Order Code RS22330
February 10, 2006

CRS Report for Congress
Received through the CRS Web

Improvised Explosive Devices (IEDs) in Iraq: Effects and Countermeasures

Clay Wilson
Specialist in Technology and National Security
Foreign Affairs, Defense, and Trade Division

Summary

Improvised explosive devices (IEDs) are responsible for many of the more than 2,000 deaths and numerous casualties suffered by U.S. and coalition forces since the invasion of Iraq.[1] The bombs have been hidden behind signs and guardrails, under roadside debris, or inside animal carcasses, and encounters with IEDs are becoming more numerous and deadly. The threat has expanded to include vehicle-borne IEDs, where insurgents drive cars laden with explosives directly into a targeted group of service members. DOD efforts to counter IEDs have proven only marginally effective, and U.S. forces continue to be exposed to the threat at military checkpoints, or whenever riding in vehicles in Iraq. DOD reportedly expects that mines and IEDs will continue to be weapons of choice for insurgents for the near term in Iraq, and is also concerned that they might eventually become more widely used by other insurgents and terrorists worldwide. This report will be updated as events warrant.

Background

Improvised explosive devices, or IEDs, now cause about half of all the American combat casualties in Iraq, both killed-in-action and wounded.[2] The Iraqi insurgents make videos of exploding U.S. vehicles and dead Americans and distribute them via the Internet to win new supporters. Outside Iraq, foreign radicals see the images as confirmation that the Americans are vulnerable. IEDs, including vehicles driven by suicide bombers, are also killing hundreds of Iraqis as insurgents also strike police stations, markets, and mosques.

---

[1] Albert Eisele, "Improved Explosives Becoming More Deadly in Iraq," *The Hill*, March 28, 2005, [http://www.hillnews.com/thehill/export/TheHill/News/Iraq/explosives1.html].

[2] Loren B. Thompson, *Iraq: Stop the Bombers, Win the War*, Lexington Institute, June 10, 2005, at [http://www.lexingtoninstitute.org/defense.asp?aid=616].

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
10 FEB 2006	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Improvised Explosive Devices (IEDs) in Iraq: Effects and Countermeasures	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Congressional Research Service The Library of Congress 101 Independence Avenue, SE Washington, DC 20540-7500**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**6**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

An IED is currently characterized as a low-technology exploding mine, usually "homemade", that is usually hidden beside a roadway and set off using a variety of trigger mechanisms. IEDs can utilize commercial, military, or homemade explosives, and often the IED builder has had to construct the IED with the materials at hand.[3] Recently, there have been reports of insurgents attacking U.S. helicopters with a new type of IED that, when triggered, can leap 50 feet into the air and spray metal fragments at low-flying aircraft. However, several DOD officials reportedly have said that such aerial attacks have not yet occurred, but are still an anticipated threat.[4] IEDs could also possibly be used in combination with toxic chemicals, biological toxins, or radiological material, but so far this has not been reported in Iraq.

Some observers speculate that munitions for constructing IEDs may be coming from a large supply of unexpended Iraqi military ordnance that was gathered and stockpiled in secret locations throughout Iraq.[5] Insurgents have constructed IEDs powerful enough to kill soldiers inside 22-ton Bradley Fighting Vehicles. In one incident in 2004, after a Bradley ran over a large IED, the armored bottom plate of the vehicle was reportedly found some 60 yards from the site of the explosion.[6] In contrast, military units equipped with the 19-ton Stryker medium-weight armored vehicle, have reportedly suffered a lower number of catastrophic vehicle losses due to enemy attack. With a maximum speed of more than 60 mph, the Stryker can dash past ambushes and roadside IEDs that might catch the slower moving Abrams tank and Bradley.[7] Between December 2003 and October 2004, news reports show that Strykers deployed in Iraq have successfully withstood 56 attacks by IEDs. Even when vehicles were rendered inoperable by the attacks, there was reportedly no loss of life among the Stryker crews.[8]

Triggering methods for IEDs may include using a cell phone, a garage door opener, or a child's remote-control toy, or may even be as simple as running over a rubber hose to produce enough air pressure to activate a switch for a mine. At other times, the insurgent may remain concealed and trigger an IED manually. The following techniques describe how insurgents can deploy IEDs to increase the damage:

---

[3] Definition from Global Security.org, at [http://www.globalsecurity.org/military/intro/ied.htm].

[4] A DOD official reportedly said that insurgents had used aerial IEDs against several U.S. helicopters. However, the Multi-National Force-Iraq reportedly has no information about attacks using aerial IEDs. Greg Grant, *Aerial IEDs Target U.S. Copters*, Defense News, January 16, 2006. Jeff Schogol, *Military Backs Off On Claim That Insurgents Are Using Aerial IEDs*, Mideast Stars and Stripes, January 20, 2006.

[5] James Glanz, Jim Dwyer, *Looting Spree Gutted Ammo Dump*, San Francisco Chronicle, October 28, 2004. Byron York, *Remember Al Qaqaa?*, National Review Online, February 28, 2005, [http://www.nationalreview.com/york/york200502280821.asp].

[6] Daniel Goure, *The Power in a Single Picture*, October 14, 2004, Lexington Institute, [http://www.lexingtoninstitute.org/defense.asp?aid=432].

[7] Daniel Goure, *Better than an Abrams*, May 28, 2004, Lexington Institute, [http://www.lexingtoninstitute.org/defense.asp?aid=38].

[8] Daniel Goure, *The Power in a Single Picture*, October 14, 2004, Lexington Institute, [http://www.lexingtoninstitute.org/defense.asp?aid=432].

- **Boosting, Coupling, and Daisy-Chaining**. Buried mines can be stacked on top of one another to increase the force of a blast. Coupling is a method of linking one mine or explosive device to another, to expand the area covered by explosions. With Daisy-Chaining, a vehicle with a heavy mine roller passes over a first, unfused device and sets off a second fused device. This in turn detonates the overpassed device underneath the vehicle.[9]

- **Shaped Charges**. A cylindrical container is packed with explosive, and capped by a conical piece of metal that becomes a molten projectile when the device is detonated. The shaped charge concentrates blast energy to punch through armor plating and propel the molten metal into the target vehicle's cabin.[10]

- **Complex Multi-Staged Ambush**. Insurgents attack a patrol with IEDs, inflicting casualties. When other First Responders arrive to help, or when a medevac helicopter touches down on a nearby landing zone, the insurgents then trigger other pre-placed bombs, or begin a follow-on attack with rifles or grenades.[11]

According to press reports, approximately 10,000 High-Mobility Multi-Purpose Wheeled Vehicles (HMMWV, or Humvees) that were not armored for combat conditions are now in Iraq. Some of these vehicles are currently re-enforced using steel plates that may still be inadequate to withstand the explosives being used by the insurgents.[12] In addition, in an apparent response to the use of heavier armor, insurgents have developed even more powerful IEDs, along with more sophisticated methods for deploying and triggering them.[13]

Also, much of the Radio Frequency (RF) spectrum in the Iraq combat theater is un-managed and can sometimes cause dangerous interference with radio communications on the ground. Sometimes IED jammers lock onto other new electronic combat systems because of a lack of coordination for spectrum usage. Other times, when a jammer is on, a soldier cannot use his radio. The soldier must shut off the jammer to send and receive, thus opening a vulnerable window for insurgents to use. Also, UAVs can sometimes lose their RF control links due to interference once they are far away from their control base. Therefore, DOD is now developing an "Electronic Warfare Coordination Cell" to help

---

[9] Global Security.org, at [http://www.globalsecurity.org/military/intro/ied.htm]

[10] John Anderson, Steve Fainaru, Jonathan Finer, "Bigger, Stronger Homemade Bombs Now to Blame for Half of U.S. Deaths," *The Washington Post*, October 26, 2005, p. A1.

[11] The Army has reportedly lost multiple helicopters in such medevac ambushes. Greg Grant, *Aerial IEDs Target U.S. Copters*, Defense News, January 16, 2006.

[12] Michael Moss, "Many Missteps Tied to Delay Of Armor to Protect Soldiers," *The New York Times*, March 7, 2005, at [http://www.globalsecurity.org/org/news/2005/050307-armor-missteps.htm].

[13] John Anderson, Steve Fainaru, Jonathan Finer, "Bigger, Stronger Homemade Bombs Now to Blame for Half of U.S. Deaths," *The Washington Post*, October 26, 2005, p. A1.

sort out problems that can endanger Explosive Ordnance Teams as they disable IEDs on the ground.[14]

Countermeasures

To evaluate countermeasures, DOD has set up the Joint IED Defeat Office (JIEDDO), directed by retired Army Gen. Montgomery Meigs, to work with various national laboratories, the Department of Energy, contractors, and academia. There is also a National Training Center at Fort Irwin, California where countermeasures are tested and recommended for deployment. The technologies being evaluated include electronic jammers, radars, x-ray equipment, robotic explosive ordnance disposal equipment, physical security equipment, and armor for vehicles and personnel.[15]

Examples of electronic jamming systems mounted on military vehicles include the IED Countermeasures Equipment (ICE) and the Warlock, both of which use low-power radio frequency energy to block the signals of radio controlled explosives initiators, such as cell phones, satellite phones, and long range cordless telephones.[16] The Army has recently ordered thousands of these radio-frequency jammer devices. However, experts reportedly caution that the jammers may only be partially effective because they must be set to operate within the right frequency range in order to stop an IED.

Other IED countermeasures being explored include technology that can first detect IEDs from afar, and then generate a pulse of directed high-power electromagnetic energy to prematurely detonate them, or burn out and destroy their circuitry. An example is the Neutralizing Improvised Explosive Devices with Radio Frequency (NIRF) which produces a very high-frequency field at very short range that can neutralize an IEDs electronics.[17] A Pentagon microwave project, code-named PING, and now deployed in Iraq, has reportedly been successful at helping locate insurgent weapons caches. The machine, which fits inside a Humvee, sends out electromagnetic waves that can penetrate the walls of a building to detect IEDs.[18] Other sensors, such as the Laser-Induced Breakdown Spectroscopy system (LIBS), are being developed to detect traces of explosives used for IEDs from as far away as 30 meters.[19]

---

[14] David Fulghum, "Jamming Jam-Up", *Aviation Week & Space Technology*, November 7, 2005, Vol. 163, No. 18, P.32.

[15] Bruce Lieberman, "SDSU professor focuses laser research on finding killer explosives in Iraq", S*ignOnSanDiego.com*, December 27, 2005, [http://www.signonsandiego.com/news /science/20051227-9999-ln27detect.html].

[16] Sgt. Stephen D'Alessio, 2nd Marine Division, *Marines schooled in new bomb protection*, July 7, 2005, [http://www.marines.mil/marinelink/mcn2000.nsf/0/ b89628064c45144e85257056003871f1?OpenDocument].

[17] Christopher Castelli, "General: Ability to Prematurely Detonate Enemy Bombs Badly Needed," *Inside the Navy*, August 22, 2005, at [http://www.insidedefense.com].

[18] Loren B. Thompson, *Iraq: Stop the Bombers, Win the War*, June 10, 2005, Lexington Institute, [http://www.lexingtoninstitute.org/defense.asp?aid=616].

[19] Sebastian Sprenger, "U.S., NATO Research Could Help Troops Detect IED Threats from Afar," *Inside the Pentagon*, May 26, 2005. Noah Shachtman, "Improvised Bombs Baffle Army,"

(continued...)

The "Talon" is a bomb-disposal Unmanned Ground Vehicle (UGV), or robot, that comes equipped with a mechanical arm to inspect and relocate suspected IEDs. More than a hundred of the remote-control robots are now being used in Iraq and Afghanistan, with an equal amount on order. Another robot, called the "PackBot" has also been used by the Army to clear bombs and explore suspected terrorist hideouts.[20]

Threat data about IEDs is tightly controlled by DOD to avoid giving feedback to the enemy about the effectiveness or ineffectiveness of different IED designs. Also, proprietary rights must be protected for those companies who produce IED countermeasures. However, these controls may sometimes limit access by other companies to important information about the effectiveness of anti-IED systems as they are tested or used in battle.[21] As a result, some industry observers say they are not getting access to all the information they need to help them create the most effective new solutions to counter IEDs, and suggest that relaxing some of the controls might lead to more solutions.[22]

Acquisition of Countermeasures

A recent GAO report indicates that acquisition delays may have increased the vulnerability of U.S. forces to the IEDs threat, stating "... specific problems delayed DOD's acquisition of three important items we reviewed (Interceptor body armor, lithium batteries, and up-armored High-Mobility Multi-Purpose Wheeled Vehicles). DOD's acquisition decision did not maximize available capacity to produce up-armored High-Mobility Multi-Purpose Wheeled Vehicles and add-on armor kits nor did it give Congress visibility over the basis for its acquisition solution. These acquisition challenges impeded DOD's ability to respond to rapidly increasing demands."[23]

Actions taken by DOD to minimize future acquisition delays reportedly include implementing a "Rapid Fielding Initiative" (RFI) to ensure that soldiers have the latest available equipment. The RFI has reportedly reduced some acquisition cycles to weeks or days.[24] Additionally, the DOD Quick Reaction Special Projects (QRSP) program now

---

[19] (...continued)
Wired News, January 26, 2005, [http://www.wired.com/news/technology/0,1282,66395,00.html].

[20] Noah Shachtman, "Improvised Bombs Baffle Army," *Wired News*, January 26, 2006, [http://www.wired.com/news/technology/0,1282,63036,00.html?tw=wn_story_related].

[21] Michael Moss, "Many Missteps Tied to Delay Of Armor to Protect Soldiers," *The New York Times*, March 7, 2005, at [http://www.globalsecurity.org/org/news/2005/050307-armor-missteps.htm].

[22] Anne Plummer, "Deadly Threat of Explosive Devices in Iraq Prompts Secrecy Debate," *Inside the Pentagon*, November 18, 2004, vol. 20, no. 47.

[23] *Defense Logistics: Actions Needed to Improve the Availability of Critical Items during Current and Future Operations*, GAO-05-275, April 8, 2005.

[24] Testimony of Claud M. Bolton, Assistant Secretary of the Army, Acquisition, Logistics and technology, before the House Committee on Armed Forces, November 2, 2005, p.2.

supports the Combating Terrorism Technology Support Office (CTTSO).[25] The CTTSO solicits proposals to identify technologies for near and long-term solutions to terrorism threats. The Technical Support Working Group (TSWG) within the CTTSO prioritizes and coordinates interagency and international research and development (R&D) for combating terrorism.[26] Also, on April 30, 2005, the Army was granted "rapid acquisition authority" by Defense Secretary Donald Rumsfeld, meaning that the traditional DOD acquisition process could be set aside, allowing a manufacturer of a special, man-portable IEDs jammer device to be chosen within only a 15-day time period.[27]

Funding for Countermeasures

The Joint IED Defeat Office has reportedly spent $378 million since 2003 to buy electronic jammers to counter IEDs. However, funding to purchase anti-IEDs electronic jammers has reportedly traditionally come through congressional plus-ups and reprogramming actions, and not through ordinary line-item funding in the fiscal year budget.[28] On May 24, 2005, Congress approved a transfer of $129.7 million from the Iraqi Freedom Fund to purchase mobile, multiband Warlock jammers which can detect threats concealed on people and in vehicles, and to support R&D and deployment for other anti-IEDs devices.[29] On July 13, 2005, a reprogramming action transferred $10 million out of Iraqi Freedom Fund for two new anti-IEDs systems: $3.5 million for 50 Small, Lightweight Advanced Modular Digital Electronic Protection Systems (SLAM-DEP), which incorporates existing jammer technology into a wearable vest, and $6.5 million to purchase 187 low-cost, expendable robots designed for explosive ordnance disposal.[30] On December 5, 2005, DOD reprogrammed an additional $278,000,000 from the Iraq Freedom Fund to be used to detect and neutralize IEDs.[31] The Department of Defense Appropriations Act, 2006, (**PL. 109-148**), signed December 30, 2005, states that $1,360,000,000 from the Iraq Freedom Fund is available for the Joint IED Defeat Office.

---

[25] Testimony of Kenneth Krieg, Undersecretary of Defense, Acquisition, Technology and Logistics, before the House Committee on Armed Forces, November 2, 2005, p.7.

[26] The TSWG uses the CTTSO Broad Agency Announcement (BAA) Information Delivery System (BIDS) to disseminate BAA information and collect proposals. TSWG operates under the policy oversight of the Department of State (DOS) Coordinator for Counterterrorism and under the management and technical oversight of the Department of Defense (DOD) Assistant Secretary of Defense for Special Operations and Low-Intensity Conflict (ASD(SO/LIC)), [https://www.bids.tswg.gov/tswg/bids.nsf/Main?OpenFrameset&6M8J6A].

[27] Glenn Maffei, "Defense Officials Worry Insurgents Will Change IEDS Tactics, Tech," *Inside the Army*, May 9, 2005.

[28] Jen DiMascio, "Pentagon Transfers $160 Million to Buy Protection Equipment," *Inside the Army*, January 17, 2005.

[29] Jen DiMascio, "Congress OKs $129.7 Million Transfer to Fund IEDS Countermeasures," *Inside the Army*, May 30, 2005.

[30] Glenn, Maffei, "Order Made for Final "Warlock" Batch to Tackle IEDS Problem in Iraq," *Inside the Army*, July 25, 2005.

[31] Reprogramming Action FY 06-09 IR.